Passive ventilation systems with heat recovery and night cooling

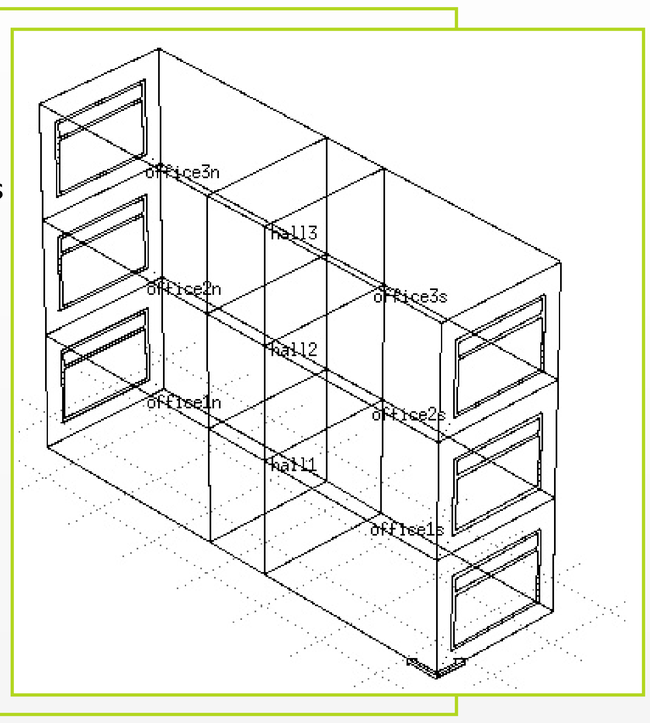
Hviid, Christian Anker; Svendsen, Svend

Publication date:
2008

A passive ventilation system with heat recovery and night cooling

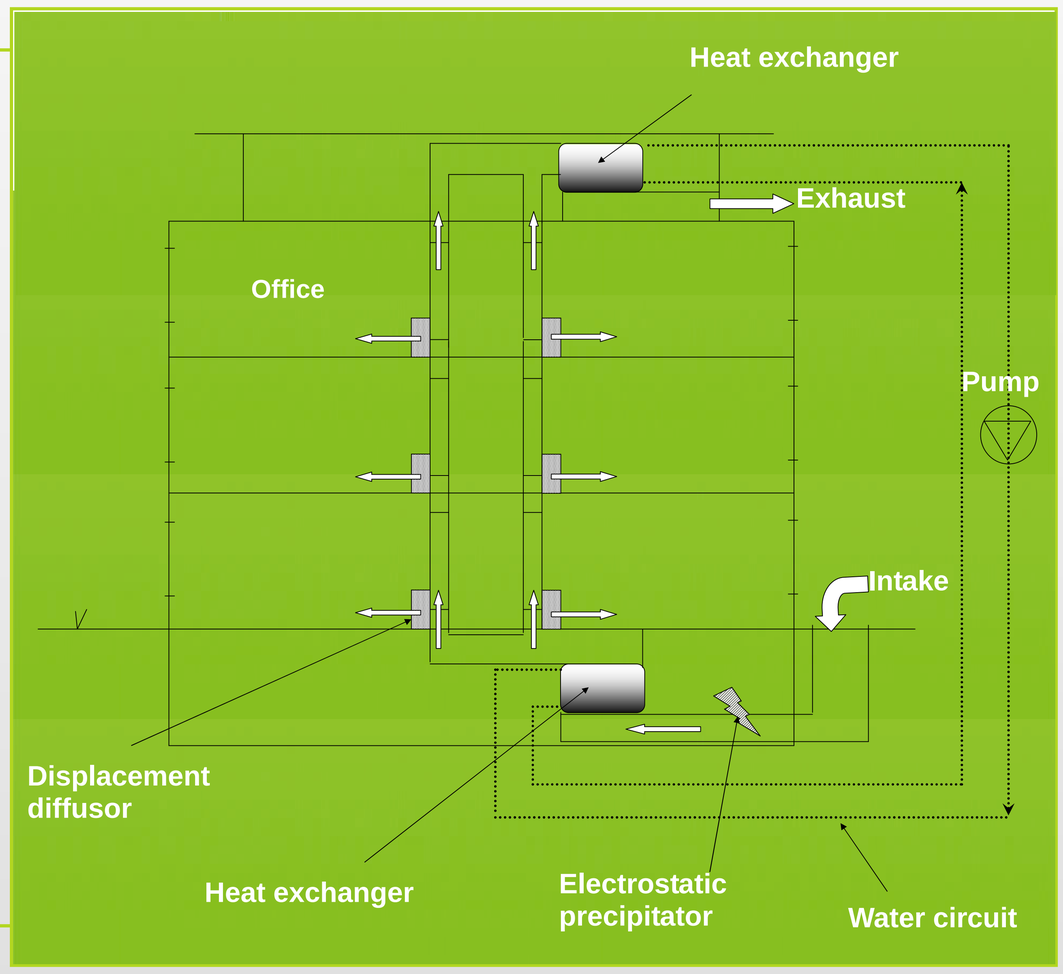
Introduction

- Passive in this context means ventilation solutions that exploit natural driving forces and the building envelope physics to establish and maintain a satisfying indoor climate without the consumption of electrical energy.
- The concept has particular potential in temperate climates with moderate wind velocities and large daily temperature differences



Passive ventilation system

- Low energy consumption
- Equal or better indoor climate compared to mechanical ventilation
- Low total costs
- Flexible solutions
- Does not occupy more space than conventional mechanical ventilation
- Indoor climate class II according to CEN15251: 7l/s per person



Input

- Building simulation program ESP-r
- Cross section with rectangular 2:1 footprint
- Façades oriented N/S
- Transparent façade: 40%
- Heavy deck construction
- Light internal partitions
- Automatic 3-step solar shading in interval 23-26°C
- Internal loads during office hours from people 5 W/m2, equipment 4 W/m2, lighting 7 W/m2
- Coupled energy and air flow network in simulation
- Heat exchangers with total pressure drop of 1.3 Pa
- Intake duct size: Ø 1000mm
- Room supply duct: Ø 250mm

Activation of passive system and windows

	Heating season		Summer	
	Work hours	Outside work h.	Work hours	Outside work h.
Passive system	On	Off	Off	On
Openings in façade	Off	Off	On	Off

Results

- Figure 1 depicts the whole-year ventilation rate through the main supply duct.
- Figure 2 depicts duration curves of ventilation rate for critical rooms during the heating season filtered by occupancy.
- Figure 3 depicts whole-year duration curves of indoor air temperature in critical rooms filtered by occupancy.

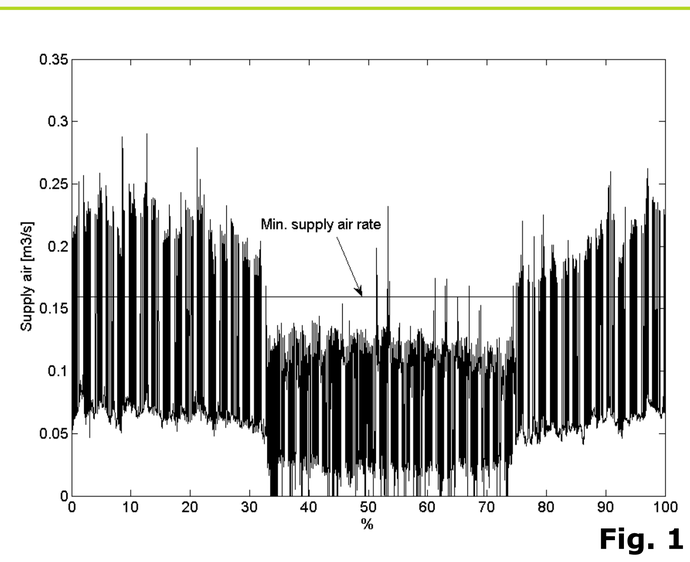


Fig. 1

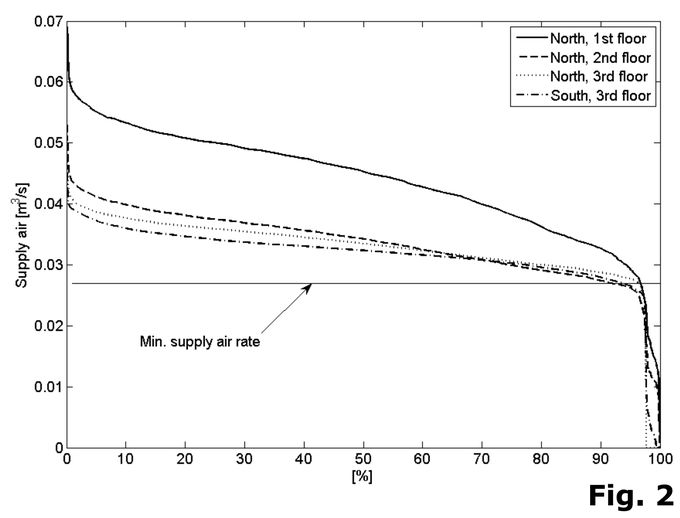


Fig. 2

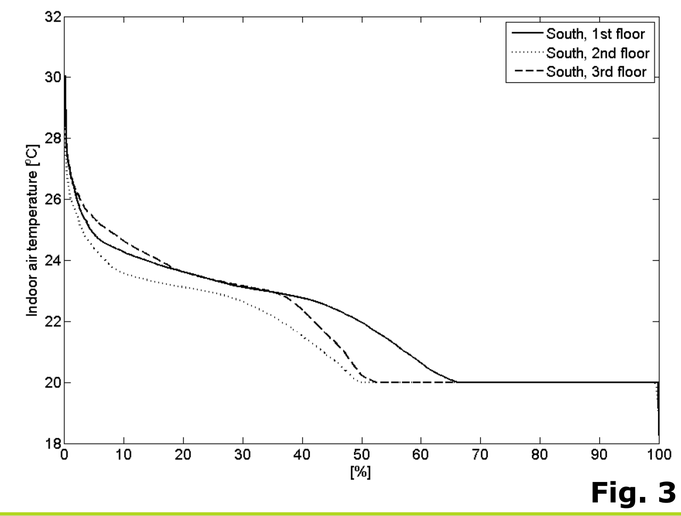


Fig. 3

Discussion

- Sufficient comfort ventilation during cold season
- Sufficient cooling power by night cooling during hot season...
- ...but comfort ventilation must be provided by natural ventilation
- Energy savings of 40% if proper damper control is applied to ventilation intake
- Air distribution has to be investigated further

Primary energy kWh/m²	Mech. vent. and cool.	Passive vent., night cool., mech cool.
Heating	100 %	103 %
Cooling	100 %	55 %
Fans	100 %	0 %
Lighting	100 %	100 %
Hot water	100 %	100 %
Total	100 %	60 %
Danish Building Code	2006	2010
	100%	53%

Conclusion

- The simulations performed in this paper indicate that passive ventilation has potential over conventional mechanical ventilation
- In conjunction with adequate night cooling both ventilation and cooling tasks are performed satisfactorily. Consequently energy consumption for fans and mechanical cooling can be saved in a passive ventilation system
- If the system is equipped with low pressure loss heat recovery and electrostatic filtering it may perform the task of ventilation, cooling and heating in high performance offices with comparable flexibility and total costs to that of conventional mechanical systems

Christian Anker Hviid

Industrial PhD student
M.Sc.
Work Space Design
ALECTIA A/S
Teknikerbyen 34, DK-2830 Virum

Phone dir.: +45 88 191 365
Cell: +45 40 879 749
E-mail: crh@alectia.com

Areas of expertise:
- Energy efficiency and optimization
- Ventilation
- Indoor climate
- Integrated design
- Total costs calculations

ALECTIA

DTU Civil Engineering
Department of Civil Engineering
Technical University of Denmark

DTU